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Biodigesters for Wastewater Treatment and Biogas Generation in Poultry Slaughterhouses

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This study evaluates the integration of a biodigester reactor into the wastewater treatment system at a poultry slaughterhouse to improve effluent quality and produce biogas as an alternative energy source. Wastewater samples were collected before and after biodigester treatment, and the parameters analyzed included Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), oil and grease, and pH stability. Biogas production was also monitored daily. The results showed significant reductions in COD (from 350 mg/L to 148 mg/L), BOD (from 225 mg/L to 82.4 mg/L), and TSS (from 180 mg/L to 32 mg/L), with average decreases of 57.83%, 63.38%, and 82.1%, respectively. Oil and grease levels decreased by 89.5%, although this reduction did not reach statistical significance (p=0,197). The pH values remained stable within the range of 6.0 to 9.0, supporting optimal microbial activity. Biogas production averaged 7.48 m^3/hour in the morning and 6.70 m^3/hour in the afternoon, demonstrating the biodigester's capacity to generate renewable energy. The findings confirm that integrating a biodigester enhances organic pollutant removal efficiency, reduces reliance on fossil fuels, and minimizes wastewater pollution, offering both economic and environmental benefits. However, further optimization is needed to effectively reduce oil and grease concentrations. This study highlights the potential of biodigester technology as a sustainable solution for managing poultry slaughterhouse wastewater, contributing to environmental protection and energy recovery

Keywords: Biodigester, Poultry Slaughterhouse, Wastewater Treatment, Biogas, Pollutant Removal

INTRODUCTION

The rapid advancement of technology and the expansion of the poultry slaughtering industry in Indonesia have significantly contributed to meeting the community's demand for animal protein (Wahyono and Utami 2018). However, this industrial growth also leads to an increase in wastewater generation, which, if inadequately managed, poses serious environmental and public health risks (Fatima et al., 2021; Nurilita Amalia Cahyani & Tuhu Agung Rachmanto, 2023). Poultry slaughterhouses produce fresh meat distributed daily to traditional markets, but simultaneously discharge large volumes of wastewater containing complex pollutants that can severely contaminate surrounding ecosystems (Mail et al. 2021).

Wastewater from poultry slaughterhouses comprises wash water, blood, and sludge containing fats, encompassing a mixture of organic and inorganic substances. This wastewater is characterized by high volume and a diverse array of pollutants (Syam & Sumarni, 2019). Improper treatment can result in water and soil pollution, foul odors, and adverse health impacts on nearby communities (Triastuti et al. 2023). Moreover, groundwater contamination linked to untreated wastewater has been associated with increased risks of stunting among children under five (Nurjazuli, Budiyono, and Arso 2025).

Several studies have documented ongoing challenges in managing poultry slaughterhouse wastewater effectively. Existing Wastewater Treatment Plants (WTP) in various poultry slaughterhouses often fail to meet regulatory standards for key parameters such as Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), and oil and grease content (Fatima et al., 2021; Nurilita Amalia Cahyani & Tuhu Agung Rachmanto, 2023). However, these challenges are particularly evident in small-to-medium scale poultry slaughterhouses, where conventional treatment systems are less effective in managing wastewater at the required scale. For example, the Ngadiyono poultry slaughterhouse in Bantul Regency illustrates these challenges: a field survey conducted in January 2023 revealed that its WTP system underperformed in pollutant removal and still emitted strong odors due to suboptimal organic matter degradation. Additionally, the solid waste generated by the treatment units remains largely unutilized, exacerbating environmental concerns (Aini, Sriasih, and Kisworo 2017).

Conventional wastewater treatment methods, including anaerobic and aerobic systems (Said and Firly 2018), coagulation-flocculation (Ashari 2020), and filtration (Rois, Pranoto, and Sunarto 2018), have been widely applied to poultry slaughterhouse effluent. However, these approaches face limitations in achieving optimal pollutant reduction and fail to fully exploit the energy potential of solid waste by products. This limitation is particularly apparent in small- and medium-scale poultry slaughterhouses, where these conventional systems do not adequately address both pollutant load and energy recovery needs. This highlights a significant research gap in the application of biodigester technology in small-to-medium scale poultry slaughterhouses, where it has the potential to address both wastewater treatment and energy production more efficiently.

This study aims to explore the effectiveness of integrating a biodigester unit as a preliminary treatment stage before wastewater enters the WTP at Ngadiyono poultry slaughterhouse. This approach aims to improve organic pollutant removal efficiency while simultaneously generating biogas as a renewable energy source. By evaluating the biodigester's performance in reducing pollutant loads and producing biogas, this research seeks to develop a more sustainable and environmentally friendly waste management model that can support the continued growth of Indonesia's poultry slaughtering industry.

METHODS

This study employed a quasi-experimental design using a One-Group Pre-test and Post-test approach, with results analyzed descriptively and analytically. Statistical analysis was conducted using the Paired Samples t-test to assess differences before and after the integration of the biodigester reactor with the Wastewater Treatment Plant (WTP) at Ngadiyono Poultry Slaughterhouse, Bantul. Data analysis was performed using SPSS for Windows software.

The study was conducted at Ngadiyono poultry slaughterhouse, Bantul, following several research stages. The initial stage involved a preliminary survey aimed at identifying the existing conditions of wastewater treatment at the slaughterhouse. This survey included interviews with poultry slaughterhouse management regarding the WTP system in use and initial observations of the characteristics of the wastewater produced. Following the survey, research permits were obtained from both the poultry slaughterhouse management and the laboratory responsible for wastewater sample analysis.

The next stage involved designing the biodigester reactor tailored to the characteristics of the wastewater at the poultry slaughterhouse. The biodigester had a volume of 10 m^3 and was designed as an upflow anaerobic sludge blanket (UASB) system, constructed using reinforced concrete. The design considered the appropriate size and capacity, accommodating a wastewater volume of 10 m^3. Upon completion of the design, the biodigester was constructed, beginning with the preparation of materials and equipment, followed by the construction process. After construction, the biodigester was initially filled with wastewater from the poultry slaughterhouse, along with inoculants to accelerate biogas formation according to the specified capacity. System functionality was checked to ensure optimal operation before sample collection. The hydraulic retention time (HRT) in the biodigester was set at 24 hours, ensuring sufficient time for the anaerobic process to effectively reduce pollutants and generate biogas.

Wastewater samples were collected and analyzed to assess treatment effectiveness. Ten grab samples were taken before and after biodigester treatment, with sampling conducted every Monday and Wednesday over five weeks. Each sample was collected in a 2-liter bottle, stored in a cooler box, and transported to the laboratory on the same day for analysis of BOD, COD, TSS, oil and grease, and pH parameters. Additionally, biogas production was measured daily for 15 consecutive days using a flow meter.

Data obtained were analyzed to evaluate the biodigester's efficiency in reducing pollutant levels in the poultry slaughterhouse wastewater. The Paired Samples t-test was applied to compare the pre-test and post-test data. The data were tested for normality using the Shapiro-Wilk test, and since the data met the normality assumption ($p > \alpha$), the Paired Samples t-test was deemed appropriate for analysis. Statistical tests were applied, and the results were compiled into research reports and scientific articles. The findings were also communicated to relevant stakeholders, including poultry slaughterhouse management.

Wastewater sample analyses were conducted following established standards. BOD was measured according to SNI 6989-72-2009, COD following APHA 23rd edition 5220-C (2017), TSS according to APHA 23rd edition 2540-D (2017), oil and grease by gravimetric method, pH as per SNI 6989-11-2019, and biogas volume using a flow meter.

RESULT AND DISCUSSION

Description of Wastewater Treatment Plant (WTP) and Biodigester Reactor at Ngadiyono Poultry Slaughterhouse

The wastewater generated from the poultry slaughtering and processing procedures directly influences the volume and characteristics of the wastewater (Aini, Sriasih, and Kisworo 2017). The Ngadiyono poultry slaughterhouse, located in Bantul, has a production capacity of 600–700 chickens per day, which can increase to up to 1,000 chickens per day during the pre-Eid season. Fidela (2024) demonstrated that biogas production using biodigester technology can be achieved simply by introducing livestock manure and water into an anaerobic digester tank.

Figure 1 shows the schematic diagram of the integration between the biodigester reactor and the wastewater treatment plant (WTP) at Ngadiyono Poultry Slaughterhouse, Bantul. The biodigester reactor is located less than 20 meters from the slaughterhouse, and the system operates continuously with an upflow system. The initial wastewater treatment process begins at the inlet, where liquid waste flows through a 4-inch pipe into a control basin. From there, the wastewater is directed to the reactor tank (digester). Inside the digester, anaerobic digestion takes place, reducing organic pollutants such as COD, BOD, TSS, and oil & grease, while also stabilizing pH. Biogas is produced during the digestion process and is transported via the gas pipe installation (shown as a black line) to the poultry slaughterhouse. It is used as fuel for medium-sized stoves typically found in small and medium enterprises (SMEs). After digestion, the treated wastewater flows into a slurry pit, then pumped into the WTP unit, which consists of several tanks for further treatment. The final effluent is discharged through the outlet after adequate processing.

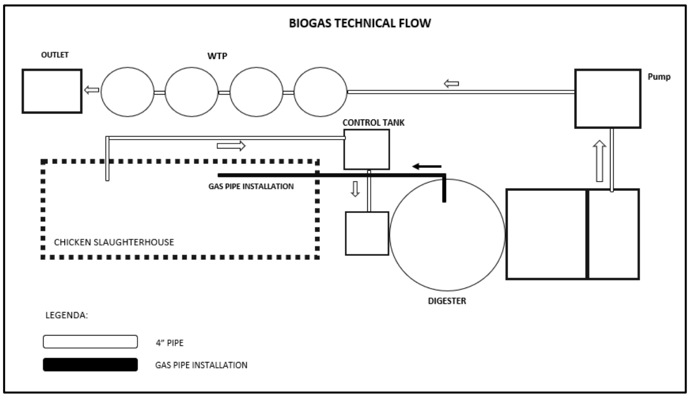

Figure 1. Schematic of Biodigester Reactor and Wastewater Treatment Plant (WTP) Integration at Ngadiyono Poultry Slaughterhouse, Bantul

The biogas generated is a product of microbial decomposition of animal waste, consisting primarily of carbon dioxide (30–40%), hydrogen (1–5%), methane (50–70%), water vapor (0.3%), and nitrogen (1–2%) (Kozłowski et al. 2023). According to Waqas et al (2023), indicators of success for a wastewater treatment installation include the efficiency in reducing organic pollutant concentrations, the amount of biomass produced, and the quantity and concentration of elements retained throughout the treatment process (Anggorowati 2023; Anshelmus 2021).

Correlation Test

The correlation test aimed to determine whether there is a significant relationship between respondent characteristics and the toxicity symptoms experienced by workers. Table 2 shows that the chi-square test result was 0.6, with a p-value > 0.05. This indicates that gender does not have a significant correlation with the symptoms experienced by the workers.

Wastewater Quality at Ngadiyono Poultry Slaughterhouse

In this study, the wastewater treatment process utilizing a biodigester reactor significantly contributed to reducing the levels of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS), which are key indicators of wastewater quality. The biodigester system was effective in breaking down the organic matter in the wastewater, improving the overall quality of the effluent before it entered the subsequent stages of treatment.

Chemical Oxygen Demand (COD)

Table 1.
COD Concentration Measurements (mg/L)

Replication	Pre-treatment	Post-treatment	Difference	% Reduction	*P-value*
1	944.93	647.87	297.06	31.44	
2	1,124.03	348.38	77.65	69.01	
3	1,081.34	374.46	706.88	65.37	
4	618.09	425.52	192.57	31.15	
5	657.41	382.02	275.39	41.89	
6	1,715.2	497.06	1,218.14	71.02	≤0.001
7	1,100.8	470.57	630.23	57.25	
8	1,382.4	494.09	888.31	64.25	
9	1,491.97	427.53	1,064.44	71.34	
10	1.311,49	320.06	991.43	75.59	
Total	11,427.66	4.387.59	7,040.1		
Average	1,146.37	438.76	704.1	57.83	

The COD levels were significantly reduced after treatment, with an average decrease of 704.10 mg/L or 57.83%. This reduction indicates the wastewater treatment system's effectiveness in lowering COD concentrations. The results show a variation in the reduction from 31.15% to 75.59%, with a significant statistical difference (p = ≤0.001) between the pre- and post-treatment concentrations. These findings suggest that the biodigester reactor effectively breaks down organic material in the wastewater, supporting its role in reducing the pollutant load before it enters subsequent treatment stages. COD is a critical parameter for assessing the organic load of wastewater, and the reduction observed in this study suggests that the biodigester was successful in decomposing a significant portion of the complex organic compounds. This reduction is consistent with previous studies that have demonstrated the ability of biodigesters to treat wastewater with high organic content.

Biological Oxygen Demand (BOD)

Table 2.
BOD Concentration Measurements (mg/L)

Replication	Pre-treatment	Post-treatment	Difference	% Reduction	*P-value*
1	863.76	546.6	317.16	36.71	0.001
2	660.26	222.92	437.34	66.24	
3	451.22	276.54	174.68	38.71	
4	411.02	373.84	137.18	33.37	
5	1,383.94	257.28	1,126.66	81.40	
6	1,059.07	245.63	813.44	76.80	
7	1,261.72	352.25	909.47	72.08	
8	1,482.47	284.62	1,197.85	80.80	
9	1,064.23	263.31	800.92	75.25	
10	844.18	232.22	611.96	72.49	
Total	9,481.87	2,955.21	6,526.66		
Average	948.19	295.52	652.66	63.38	

BOD levels were also significantly reduced after treatment, with an average decrease of 652.66 mg/L or 63.38%. The percentage reduction ranged from 9.04% to 81.40%, demonstrating the system's ability to effectively lower BOD concentrations. The paired samples t-test showed a significant difference in BOD levels ($p = \leq 0.001$). The biodigester appears to play a crucial role in reducing organic pollutants and enhancing the efficiency of the WTP. BOD is an important measure of the oxygen required by microorganisms to decompose organic matter, and the reduction observed suggests that the biodigester provided a favorable environment for microbial activity, particularly for those involved in the anaerobic digestion of organic compounds.

Total Suspended Solid (TSS)

Table 3.
TSS Concentration Measurements (mg/L)

Replication	Pre-treatment	Post-treatment	Difference	% Reduction	*P-value*
1	518	124	394	76	≤0.001
2	436	40	396	91	
3	980	22	958	98	
4	520	86	434	83	
5	254	60	194	76	
6	660	104	556	84	
7	284	76	208	73	
8	548	79	469	86	
9	256	94	162	63	
10	664	60	604	91	
Total	5,120	745	4,375		
Average	512	74.5	437.5	82.1	

TSS concentrations experienced an average decrease of 437.5 mg/L or 82.1%, with reductions ranging from 63% to 98%. The significant reduction in TSS supports the effectiveness of the biodigester in removing suspended solids, an important step in improving wastewater quality. Statistical analysis using the paired samples t-test confirmed the significant difference ($p = \leq 0.001$) between pre- and post-treatment TSS levels. Suspended solids can contribute to water pollution and hinder further treatment processes, so their removal is a crucial step in improving the quality of wastewater. The results in this study align with other research that emphasizes the role of biodigesters in removing suspended solids and improving effluent quality.

The significant reduction in Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), nd Total Suspended Solids (TSS) can be attributed to several factors, one of which is pH stability, which supports the growth of decomposing microorganisms. These results indicate that the biodigester is effective in degrading organic matter in the wastewater of the Poultry Slaughterhouse (Hasanah and Sugito 2017). The anaerobic process within the biodigester plays a crucial role in breaking down complex organic compounds into simpler substances, thereby reducing the pollutant load before the wastewater enters the subsequent treatment stages in the Wastewater Treatment Plant (C. Guimarães, Maia, and Serra 2018; Said and Firly 2018). The effectiveness of the biodigester in reducing organic pollutant levels aligns with previous studies that demonstrate biodigester technology as an effective alternative solution for treating wastewater with high organic content from industrial sources (Attamimy, Putra, and Sukmawaty 2024; Nurrachma and Prayitno 2023).

Potential Hydrogen (pH)

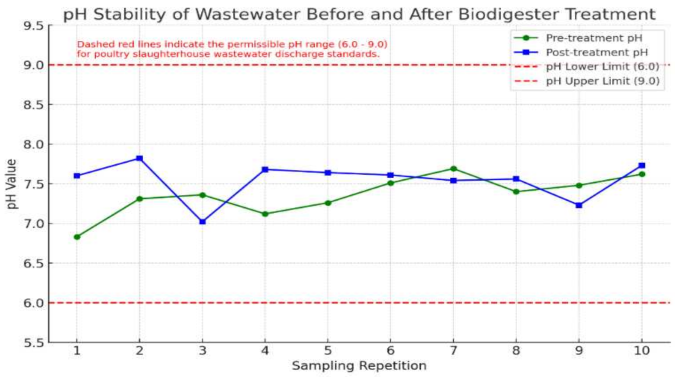

Figure 2. pH Stability Trend Before and After Treatment

Figure 2 illustrates the trend of pH stability before (Pre) and after (Post) wastewater treatment using the biodigester reactor. The pH values remained within the standard quality range 6.0–9.0, as indicated by the dashed red line. This confirms that the treatment system effectively maintains pH stability within a safe range for the environment (Dhakal, Karki, and Nakarmi 2016).

The pH stability is crucial for ensuring the proper functioning of the biodigester and supporting the growth of microorganisms involved in organic matter degradation, particularly those responsible for biogas production. Stable pH levels also prevent the disruption of microbial activity, which is essential for the effective breakdown of organic compounds (Pratama, 2024). In the biodigester, maintaining a consistent pH ensures efficient microbial processes, facilitating the conversion of wastewater into biogas.

pH plays a critical role in the anaerobic digestion process that leads to biogas formation. Methanogenic bacteria, which are responsible for methane production, are particularly sensitive to pH fluctuations. The optimal pH range for these bacteria is generally between 6.5 and 7.5. When the pH deviates from this range—either becoming too acidic or too alkaline—methanogenic activity is inhibited, leading to a reduction in biogas production (Ali et al., 2019; Ceron-Vivas et al., 2019; Wang et al., 2019). Therefore, controlling the pH within the optimal range is essential for maximizing biogas yield and ensuring the efficiency of the anaerobic digestion process.

Furthermore, an unstable pH can disrupt the microbial balance in the digester, potentially halting biogas production altogether. Therefore, effective pH management is not only vital for the treatment process but also for maintaining the efficiency and stability of the biodigester system (Rodríguez-Torres et al. 2021).

Oil and Grease Concentration

Table 5.
Oil and Grease Concentration Measurements (mg/L)

Replication	Pre-treatment	Post-treatment	Difference	% Reduction	*P-value*
1	7.33	1.00	6.33	86	0.197
2	51.33	5.33	46	90	
3	4.33	0.33	4	92	
4	10.33	1.00	9.33	90	
Total	73.32	7.66	65.66		
Average	18.32	1.91	16.41	89.5	

Despite the numerical reduction in oil and grease concentrations (average decrease of 16.41 mg/L or 89.5%), the paired samples t-test revealed that this reduction was not statistically significant ($p = 0.197$). The presence of oil and grease in the wastewater is a common challenge in poultry slaughterhouses due to the recalcitrant nature of these compounds. The biodigester alone may not be sufficient to fully address this issue, suggesting the need for additional pre-treatment methods, such as grease traps or filtration systems, to enhance the reduction of oil and grease concentrations.

Managing oil and grease in poultry slaughterhouse wastewater remains a significant challenge due to the persistent and difficult-to-degrade nature of these substances. If not properly treated, oil and grease can severely pollute the surrounding environment. Typically, a biodigester alone is not sufficient to fully address this issue, highlighting the need for additional treatment methods to achieve more effective reductions in oil and grease concentrations (Romadon and Hendrasarie 2023).

One approach to improving oil and grease removal is by implementing pre-treatment steps, such as grease traps or filtration systems, before the wastewater enters the biodigester. A grease trap works by separating oils and fats from wastewater, preventing them from burdening the biodigester and other treatment stages. In addition, filtering out solid waste like feathers, meat scraps, fats, and other remnants before they reach the control basin could be beneficial. This waste could then be processed into fish feed pellets, adding value to the waste and supporting a circular economy (Wong et al., 2016).

Another promising alternative for improving the reduction of oil and grease is the use of a Lactobacillus sp. bacterial consortium. This consortium can assist in breaking down fats and oils by hydrolyzing triglycerides into fatty acids and glycerol, making them easier to degrade in the anaerobic environment of the biodigester. Incorporating Lactobacillus sp. into the treatment process could enhance the biodigester's ability to handle oil and grease more efficiently, while also accelerating the fermentation process for biogas production concentrations (Novirina Hendrasarie et al., 2023; Romadon & Hendrasarie, 2023).

Overall, the integration of a biodigester within the WTP system at Ngadiyono Poultry Slaughterhouse provides several significant advantages. First, the biodigester effectively reduces the organic pollutant load in the wastewater before it enters subsequent treatment stages, thereby enhancing overall WTP efficiency and reducing environmental pollution risks (Apriandi 2021). Second, biogas production from the biodigester offers a valuable alternative energy source (Ebeya et al. 2022). Third, improved wastewater management enhances the poultry slaughterhouse's image as an environmentally friendly industry (C. de S. Guimarães and Maia 2023). The use of biodigester technology not only mitigates the environmental impact of wastewater but also provides economic benefits through biogas production (Abubakar 2022). This study contributes to the development of environmentally friendly wastewater treatment technologies and supports the growth of the poultry slaughtering industry in Indonesia.

Biogas Production Frequency from the Biodigester Reactor Design at Ngadiyono Poultry Slaughterhouse

Monitoring results from the flow meter in May 2024 indicate that biogas produced at Ngadiyono Poultry Slaughterhouse has been successfully utilized as a substitute for LPG gas in chicken processing activities. This is evidenced by the daily fluctuations recorded by the flow meter. The biogas formation process is accelerated through seeding by adding cow manure from day 1 to day 7. This inoculation aims to promote the growth of decomposer microorganisms, thereby expediting biogas production (Grace Roma Artha Samosir & Merry Meryam Martgrita, 2021). With the addition of cow manure, sufficient biogas production can be expected between 15 and 30 days. Flow meter monitoring also serves to detect any leakage in the biogas system. By day 15, biogas was already produced, although pressure had not yet stabilized. Between days 20 and 30, biogas pressure stabilized, and the gas was deemed suitable for fuel use.

Biogas volume was measured using a flow meter to determine the flow rate of the gas. Flow meters come in various types, designed for specific applications and operating principles (Araujo and Oliveira 2024). Measurements were taken twice daily: before biogas use in the morning and after use in the afternoon. The recorded flow meter data are presented in Table 6.

Table 6.
Flow Meter Measurements of Biogas at Ngadiyono RPA

No.	Day	Morning (m^3/hour)	Afternoon (m^3/hour)
1.	1	8.1	4,9
2.	2	8.4	5,9
3.	3	7.1	6,9
4.	4	7.5	8
5.	5	8.9	8,9
6.	6	9	9
7.	7	9	9
8.	8	7.1	5,5
9.	9	6.5	4
10.	10	6.5	6,5
11.	11	8	8
12.	12	6	5,5
13.	13	7.2	7
14.	14	8	8
15.	15	4.9	3,5
Total		116,7	99.1
Average		7,78	6.61

Biogas production was monitored using a flow meter over 15 days, with average morning production of 7.78 m^3/hour and afternoon production of 6.61 m^3/hour. The biogas production fluctuated daily due to factors such as the volume of waste processed, ambient temperature, and biodigester operational conditions (Tangko et al. 2019). Despite these fluctuations, the biogas produced was successfully utilized as a substitute for LPG in chicken processing, contributing to operational cost savings and reducing dependency on fossil fuels.

The fluctuations in biogas production are influenced by several factors, including the C/N ratio of the organic waste and ambient temperature. A higher C/N ratio can lead to more stable and higher biogas production (Okonkwo et al., 2018; Shahbaz et al., 2020). The formation of methane (CH4), a primary component of biogas, is driven by the activity of methanogenic bacteria under anaerobic conditions. This process involves the microbial breakdown of organic materials into simpler compounds, including methane, which is a valuable energy source (Verbeeck et al., 2021). Maintaining an optimal C/N ratio and temperature range is crucial for maximizing methane production and ensuring the efficiency of the biodigester system.

Biogas is produced via anaerobic decomposition of organic materials or fermentation without oxygen (Caposciutti et al. 2020; Indran et al. 2021). Optimal biogas composition, maximum volume, and flame test are indicators of biogas quality (Dewi and Visca 2020). According to Aditama (2022), waste-to-biogas systems integrated with wastewater treatment plants present business opportunities for SMEs and valuable assets. Biogas primarily consists of methane (CH_4), carbon dioxide (CO_2), and small amounts of other gases (Styana, Widodo, and Cahyono 2022).

The biogas production observed in this study demonstrates that the biodigester effectively generates a valuable byproduct. Utilizing biogas as an alternative energy source reduces a poultry slaughterhouse's dependency on fossil fuels such as LPG. Despite the observed fluctuations in production (average 7.78 m³/hour in the morning and 6.61 m³/hour in the afternoon), biogas use provides both economic benefits and contributes to reducing greenhouse gas emissions (Elizabeth 2021). Therefore, biogas production from organic waste represents an environmentally friendly and safe waste management solution (Alengebawy et al. 2024; Huwaida et al. 2024).

CONCLUSION

Based on the results of this study, the integration of a biodigester reactor into the wastewater treatment system at Ngadiyono Poultry Slaughterhouse proved effective in reducing pollutant concentrations, producing biogas as an alternative energy source, and maintaining wastewater pH stability within regulatory standards. Significant reductions in Chemical Oxygen Demand (COD) (from 1,146.37 mg/L to 438.76 mg/L, a 57.83% reduction), Biochemical Oxygen Demand (BOD) (from 948.19 mg/L to 295.52 mg/L, a 63.38% reduction), and Total Suspended Solids (TSS) (from 512 mg/L to 74.5 mg/L, an 82.1% reduction) demonstrate the biodigester's ability to effectively degrade organic matter.

Biogas production offers both economic and environmental benefits. The biogas produced can be used as a renewable energy source, replacing conventional fuels such as LPG. Based on monitoring data, biogas production averaged 7.78 m³/hour in the morning and 6.61 m³/hour in the afternoon. This biogas production can potentially reduce LPG consumption by approximately 12 kg per day, leading to significant cost savings in fuel use. Although the reduction in oil and grease concentrations was not statistically significant ($p = 0.197$), this study highlights the potential of biodigester technology as an environmentally friendly and cost-effective solution for managing poultry slaughterhouse wastewater.

SUGGESTION

Based on the results of this study, it is recommended that the owner of Ngadiyono Poultry Slaughterhouse utilize the biogas produced by the Wastewater Treatment Plant (WTP) as a renewable energy source. This biogas can significantly reduce the reliance on conventional fuels like LPG, providing both economic benefits and sustainability.

For future research, it is suggested that researchers explore the potential of biodigester sludge as an organic fertilizer. The solid byproduct of the biodigestion process can be used to improve soil quality by enriching it with essential nutrients. Further studies could also focus on combining various technologies, such as grease traps or mechanical filtration systems, with biodigester technology to improve the reduction of oil and fat concentrations in poultry slaughterhouse wastewater. This integrated approach could help optimize the treatment process, ensuring that all key parameters, such as BOD, COD, and TSS, meet the required environmental quality standards.

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